FXM5 Stand Alone Mode with Field Weakening
This is pertinent to Mentor II / Quantum III drives

Background:
This document attempts to outline the procedure on how to setup the FXM5 when operating in stand alone mode- primarily with our Mentor II and Quantum III drives but also with any DC Drive.

DC motors can be designed for operation above their Base Speed. To accomplish this, the drive will run the motor up to full rated speed (base speed) using full armature voltage and full field current. Then, to obtain greater speeds, the drive will keep the armature voltage constant but reduce the field current thereby achieving higher speeds. This area of operation is often referred to as the:

- Constant HP area
- Extended Speed Range
- Field Weakened zone

As the speed increases, available torque is reduced therefore, delivered horsepower remains the same. Motors that are designed with this capability are known as Field Range Motors and will typically have 2 speeds and 2 Field Currents stamped on the nameplate. See the example below.

<table>
<thead>
<tr>
<th>Motor Field Current</th>
<th>1.56 / 1.11 amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Rated Speed</td>
<td>1750 / 2300 RPM</td>
</tr>
<tr>
<td>Base Speed</td>
<td>Fully Weakened Speed</td>
</tr>
<tr>
<td>Full Field amps</td>
<td>Fully Weakened Field amps</td>
</tr>
</tbody>
</table>

The motor will deliver full Torque and Horsepower only at Full Field, Full Armature Voltage and Full Armature amps.

CAUTION
One must never exceed the TOP RPM of the motors designed limits. Motors can self destruct and eject internal components in all directions if RPM's exceed this speed. If the TOP SPEED is not on the Motor Nameplate, we would suggest you contact the Motor Manufacturer for this data.

For setting up the FXM5 in Stand alone mode without Field Weakening:

Please click CTTN152
NOTE: Field Weakening requires a form of actual motor shaft speed feedback. This means that the motor must be fitted with either an AC, DC or Digital Pulse Tach (Encoder).

Procedure:
1. Determine the field current from the motor's nameplate. Some nameplates will have multiple currents like shown below; this is used to attain the higher speed rating and operate in the Constant Horsepower Range.

2. Next select a setting for the FXM5 that is a higher value than desired and then can be later adjusted down. In the example above the Full Field current rating is 1.56. In order to achieve the 1.56A we would select 2A from the chart (Column A).

A. Adjust the number of turns through the current transformer: Column B (10 turns). Correct turns can be determined by counting the number of wires going over the top of the Current transformer. For example, the photo below shows 3 turns through the transformer.

<table>
<thead>
<tr>
<th>Maximum Field Current</th>
<th>Number of Primary Turns</th>
<th>LK1 Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>15/Np</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>20/Np</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>15/Np</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>20/Np</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>20/Np</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>20/Np</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>20/Np</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>20/Np</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>20/Np</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>20/Np</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>15/Np</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>15/Np</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>15/Np</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>15/Np</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>15/Np</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>20/Np</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>20/Np</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>20/Np</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>20/Np</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>20/Np</td>
</tr>
</tbody>
</table>
B. Place the LK1 to the proper setting: **Column C (LK1 – 20/Np)** –from page 2

C. Adjust the FXM5 control transformer for the AC voltage that is being supplied.

D. Set LK2 for the armature voltage of the motor. Either < 470V or > 470V. This is used in association with the Armature Voltage Pot (RV1) for Field Weakening which will be explained further on.

E. Connect the A1 & A2 of the FXM5 to the armature of the drive. This must be fused externally with a 500V,2A fast acting fuse for each connection.
F. A scheme **must** be in place in the event of a field loss- disabling the motor from operating is a necessity. If using a Mentor II or a Quantum III the Application Note **CTAN 298** will assist you with this setup.

http://www.emersonct.com/download_usa/appNotes/CTAN298.pdf

<table>
<thead>
<tr>
<th>TB1</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Common contact</td>
</tr>
<tr>
<td>9</td>
<td>Field-current failure relay</td>
</tr>
<tr>
<td>10</td>
<td>Contact open when field current is normal</td>
</tr>
</tbody>
</table>

**Initial Pot Settings**

3. **Initial Pot Settings**– The directions of **RED** arrows show the maximum setting of each pot. Set the Max current pot to the vertical position. This will only allow ½ of the maximum current when initially powering up. **Step 6** will show how to do final calibrations to the pot for the proper field current desired.
4. **Field Economy Circuit** – Terminals 1 & 2 of the FXM5 board is for Field economy. Connection between these terminals will allow for full field current output as set by Pot RV2. This is needed for our initial setup of the FXM5.

An open connection between terminals 1 & 2 will cause the output current to change to the minimum output current value as set by Pot RV3.

<table>
<thead>
<tr>
<th>TB1</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Field economy contact Connect to terminal 2 for normal operation Disconnect for field economy</td>
</tr>
<tr>
<td>2</td>
<td>0V common</td>
</tr>
</tbody>
</table>

If using the FXM5 in stand alone mode in conjunction with either the Mentor II or the Quantum III, a technical note describing all of the necessary steps needed to have this automatically implemented into your system:

**By Clicking CTTN 303 or**


5. **Apply Power to the FXM5 field regulator and to the drive.**

Check the number of bars on the Bar Graph LED display - it should be showing about 5-6 bars or so. If all bars are lit- turn off power and re-check your jumper settings and the direction of the wire running thru the Current Transformer and re-check the number of turns.
6. **Calibrate the Maximum Field Current Pot RV2** - During the initial set up it is also possible to use the FXM5 as a “meter”. The **IF MAX** (10 Segments) displays the current output of the field regulator with relationship to the amount of turns through the current transformer (Section 2A) and the LK1 setting (Section 2B). This represents the maximum current for the **settings** and not the absolute maximum of the FXM5 (20 amps).

Adjusting the **Max Field Pot (RV2)** Counter Clockwise will start to reduce the output current from the FXM5.

**WARNING: This is a single turn pot; adjustments to this pot can be drastic.**

In the example pictured below, the current transformer has 10 turns and the LK1 set to the 20/Np position. If all 10 segments were lit, the output current would be 2A. Each segment represents **10%** of the maximum current that the FXM5 is set for.

To achieve the 1.56 Amps of the example motor. We would expect to see 8 segments or 80% of 2A to equal approximately 1.6A. Verify the output current with either a clamp-on amp meter or a meter wired in series. (Pictured to the right)

After this value is found it is suggested that it is marked with a fine point pencil to indicate the maximum field current of the motor.
7. **Calibrate the Armature Voltage Pot (RV 1)** – Calibration of this pot is a multiple step procedure.

- Press the Min Field Adjustment Button. Adjust the Min Field Pot (RV3) down (counter clockwise) one LED bar segment from the previous setting by the Max field pot. LED 1 should go out.

- Alternately, release and press the Min Field Adjustment Button and you should see the 10 segment display change **ONLY** one segment up and down.

- Determine the Armature Voltage Cross-Over point. This is typically set to about 95% of the maximum Armature voltage.

  - **500V Armature = 480V Armature Cross over Voltage**
  - **240V Armature = 230V Armature Cross over Voltage**

- Monitor the Armature Voltage with a Digital Voltmeter. (If using the Mentor II or Quantum III Parameter #3.04 can be used.)

- With the **Drive Set for Armature Voltage Feedback**, bring the armature voltage up to the selected value in the above step.

<table>
<thead>
<tr>
<th>For Mentor II and Quantum III Drives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set Parameter # 3.12 = 0</td>
</tr>
<tr>
<td>Set Parameter # 3.13 = 1</td>
</tr>
<tr>
<td><strong>Sets the unit up for AVF Feedback</strong></td>
</tr>
</tbody>
</table>

| Set Parameter #3.15 = the maximum motor Armature Voltage |

Factory defaults for Mentor II are set for Tach Feedback and 600v for Armature Voltage- so these need attention.

- Slowly start turning the Max Armature pot (RV1) Counter Clockwise until the 10 segment bar graph display decreases in value one segment.

- Turn the speed reference down to zero, disable the drive and **power down** the system.

- Mark the Max Armature Pot with a fine point pencil.

- Turn **BOTH** the Max Armature Pot (clockwise) & the Min Field Current pot (Counter clockwise) back to the maximum value.
8. **FIELD WEAKENING** - Adjusting the FXM5 for Field Weakening and the Drive Tach Feedback calibration is also an in-depth process. On initial setup the Drive should remain setup in **Armature Voltage Feedback (AVF)** but the tach wires should be attached to the drive at this point.

- Determine what the maximum speed your motor needs to go based on your system/machine needs and do all calculations necessary.

It must be pointed out that just because your motor can spin 2500rpm- it **DOES NOT** mean that your machine was designed to run at that motor speed!!!

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**Substantial damage to the machine or other hazards could result without consulting the machine manufacturer first in consideration to the maximum machine design limitations.**

Identify what your output tach voltage should be.

- Calculate what voltage the Tach would be at:
  - Base speed _________ Vdc
  - Maximum speed _________ Vdc
  - Desired speed _________Vdc

**Example:**

Motor info
1750RPM Base Speed
2300 RPM Maximum

- a) 2150 is the Max Speed needed
- b) DC tach 50V / 1000RPM
- c) Calculated voltage
  - 87.5 Vdc
  - 115 Vdc
  - 107.5 Vdc

**For Mentor II and Quantum III Drives**

- Select the proper scaling of SW1 on the MDA 2B board for the maximum DC tach voltage under drive cover. In the example above, 107.5Vdc will be produced at maximum speed. In this case Switch 7 would be selected.

In the adjacent photo, SW 8 is shown being selected. Positioned to the right.

- Place a Digital Voltmeter across the Tachometer terminals. (Alligator clips work the best and keep your hands free.)
- Re-apply power to the drive.
- Run the machine in Armature Voltage Feedback (AVF) to maximum armature voltage. At this point the motor should be at or near the base speed. Verify this speed with the voltage produced by the tach.
• **Slowly** start to decrease the Max Current Adjustment Pot (RV2) counter clockwise. Watch the Digital Voltmeter as you decrease the pot to obtain the desired tach voltage (in the example it was 107.5Vdc). At this point both LED’s on the FXM5 will be illuminated.

• Adjust the Min Field Current Pot (RV3) clockwise down until LED 2 just barely goes out.

• Now slightly adjust the Min Field Current Pot (RV3) counter clockwise to just turning both LED’s back on. At this point, the Min Field Push button can be pressed and there should be no change in the speed.

• Mark with a Fine point pencil the Min Field Current Pot (RV3).

9. **DRIVE SPEED CALIBRATION** – This is the point that the Feedback (Tach in our example) needs to be calibrated to the drive. Different drive manufacturers may have different means to calibrate Speed Feedback. In the next section we will discuss our procedure for the Mentor II and Quantum III drives.

• View Parameter # 3.26 in the Parameter Index Screen with the drive at our desired speed. The value, if running in the forward direction, should be a **Positive (+) value**.

⚠️ **A negative (-) value seen in this parameter is not correct if running in the forward direction. This means that the tach wires are reversed and needs to be resolved before running in tach mode.**
• Adjust the Tachometer Max Speed Pot (pictured above) to the Value of 999 at Parameter # 3.26. If the display still shows 1000 keep adjusting this pot Clock wise until 999 is shown. This is a multi-turn pot (20 turn) so several turns maybe needed to see any results.

• After the Tachometer pot on the drive has been set. Adjust the Max Field Current Pot (RV 2) clockwise back to the maximum field current setpoint previously marked with the pencil.

• Reduce the speed command reference to the drive to zero and then press the stop command.

• Calibrate all 3 pots to the setpoints marked by the pencil.

10. Parameter changes:
• Set Parameter # 3.12 = 0
• Set Parameter # 3.13 = 0 } Sets the unit up for Tach Feedback

• Speed Loop Adjustments:
  • Parameter # 3.09 = 20
  • Parameter # 3.10 = 5 } This will dampen the response of the tach appropriately

• Save parameters in the drive. To see a video demonstration of how to Store Parameter, click the following link:

  CTVI 122

  http://www.emersonct.com/download_usa/videos/ctvi122.wmv
Finally test and verify that the motor is able to get up to the desired speed that it was set for.

For setting the FXM5 up in Stand alone mode **without** Field Weakening:

Please click [CTTN152](#)

Questions: Ask the author ??

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